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Economic Impacts of an Intensified Timber Management Program

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ECONOMIC IMPACTS OF AN INTENSIFIED TIMBER MANAGEMENT PROGRAM

By

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PREFACE

This report presents estimates of changes in timber product prices, consumption levels, consumer expenditures, and national income that would result from an intensified timber management program on nonindustrial private and National Forest lands described in a recent Forest Service report "The Outlook for Timber in the United States." It also contains a discussion of the possible impacts of the intensified program on profits, employment, and payrolls; and a review of selected multiplier studies with a listing of recent literature on multiplier analysis.

The research for this report was carried on by the author while under a temporary appointment with the Division of Forest Economics and Marketing Research, Forest Service, during the summer of 1973.

McKillop, William.
1974. Economic impacts of an intensified timber management program. USDA Forest Service, Division of Forest Economics and Marketing Research, Washington, D.C. Research Paper WO–23, 16 p.

This analysis shows that substantial benefits would accrue from an intensified softwood sawtimber management program described in the recent Forest Service study, "The Outlook for Timber in the United States." It was estimated that in the year 2000 output of softwood timber products would be 7 percent higher and prices 5 percent lower with this program than they would be if the program was not undertaken. Savings to consumers, which would result from program-induced changes, were estimated to be $484 million in year 2000; net secondary benefits were estimated to be $472 million after allowing for the reduction in output of substitute materials. Substantial secondary benefits were estimated for other years in the study period.

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INTRODUCTION AND HIGHLIGHTS

The recent Forest Service report on the timber situation,[1] "The Outlook for Timber in the United States," contains projections of timber demands to 2000 under alternative population, economic, and price assumptions; and projections of timber supplies to 2020 under alternative management assumptions. It also contains estimates of increases in softwood sawtimber supplies that might be realized from continuing programs of intensified management on private nonindustrial and National Forest commercial timberlands which would yield more than 5 percent return on the investment.

The Forest Service projections of softwood sawtimber demands and supplies are shown in table 1. The projected quantities that would be demanded and supplied if softwood timber product prices did not rise relative to other commodities show "demand" exceeding "supply." This means that timber product prices would have to rise relative to other commodities to bring supply and demand into balance. Alternatively, if softwood timber product prices rise by 1.4 percent annually in relation to other commodities, demand and supply are approximately balanced in 1980, but thereafter demand would be reduced because of the rapid relative price increases. The third group of figures indicates what might happen if softwood timber product prices experienced a once-and-for-all relative price rise of 30 percent. The quantity supplied in the year 2000 at this price level would fall short of the quantity demanded unless a program of intensified timber management was undertaken. Demand and supply levels for all

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[1] U.S. Department of Agriculture, Forest Service. 1973. The outlook for timber in the United States. Forest Resource Rep. 20, 367 p.

Table 1.—Quantities of softwood sawtimber demanded and supplied from U.S. forests under alternative price assumptions

Item		1970	1980	1990	2000
1970 relative prices[1]	1970 dollars	119	119	119	119
Quantity demanded[2]	billion board feet	46.2	57.9	65.6	71.8
Quantity supplied[2]	do	46.2	46.8	47.4	47.0
Quantity supplied with intensified management[2]	do	n.a.	n.a.	n.a.	n.a.
Rising relative prices[3]	1970 dollars	119	137	157	181
Quantity demanded[2]	billion board feet	46.2	48.2	48.9	49.1
Quantity supplied[2]	do	46.2	48.0	49.6	51.0
Quantity supplied with intensified management[2]	do	n.a.	n.a.	n.a.	n.a.
Relative prices 30 percent above 1970[4]	1970 dollars	119	155	155	155
Quantity demanded[2]	billion board feet	46.2	44.7	50.6	56.7
Quantity supplied[2]	do	46.2	50.8	50.0	48.6
Quantity supplied with intensified management[2]	do	n.a.	52.4	52.7	53.3

[1] Base price: weighted average price (1970 dollars) per thousand board feet for softwood lumber, softwood plywood, and other softwood products. Estimated by national average appraised selling price in Forest Service sales for calendar year 1970.

[2] Op cit. The outlook for timber in the United States. Table 155, p. 216.

[3] Base price of $119 rising at 1.4 percent per year compound growth rate. The 1.4 percent rate represents a weighted average of 1.5 percent for softwood lumber and 1 percent for softwood plywood.

[4] Base price of $119 plus 30 percent.

n.a. = not available.

three assumptions indicate that in the absence of intensified management, softwood timber product prices would have to rise for supply and demand equilibrium to occur.

Table 2 shows the "equilibrium" prices and production levels, that is, the levels that would prevail with supply and demand in balance. Estimates are shown with 1970 levels of timber management (with "some adjustments for recent environmental constraints on National Forest harvests") and with the program of intensified timber management referred to above.

These data show that softwood timber output will be 50.4 billion board feet and product price will be $175 per thousand board feet in the year 2000 if the intensified management program is not undertaken. Adoption of the program will lead to a 7 percent (3.6 billion board feet) increase in output and a 5 percent ($9) decrease in price. Because of the nature of the program the major timber supply impact occurs after it has been in operation for some time. The impact of the program was analyzed for a 50-year period by the Forest Service. Gains due to the program were predicted to increase steadily from its inception to the end of the period of analysis. Since impacts are assessed in this report only up to the year 2000, the net program benefits may be underestimated.

Impacts of intensified management on consumer savings and national income

The implications of the intensified management program in terms of savings to consumers and national income are presented in table 3. Savings

Table 2.—Estimates of "equilibrium" price and output levels for softwood sawtimber and changes due to intensified timber management

Item		1980	1990	2000
Current management				
Output	billion board feet	48.9	49.8	50.4
Price per thousand bd. ft[1]	1970 dollars	140	155	175
Intensified management				
Output	billion board feet	50.3	52.3	54.0
Price per thousand bd. ft.[1]	1970 dollars	137	150	166
Change due to intensified management				
Output	billion board feet	+1.4	+2.5	+3.6
	percent	+2.9	+5.0	+7.1
Price[1]	1970 dollars	−3	−5	−9
	percent	−2.1	−3.2	−5.1

[1] Estimate rounded to nearest dollar.

Table 3.—Secondary benefits from intensified timber management, 1980, 1990, and 2000

Item	1980	1990	2000
	Millions of 1970 dollars		
Savings to consumers[1]	+166.3	+278.9	+483.8
National income generated by increase in timber products output	+170.7	+332.9	+530.6
Change in national income due to decrease in output of substitute products	−174.5	−340.3	−542.5
Secondary benefits	+162.5	+271.5	+471.9

[1] Computed from price and output data before rounding.

to consumers plus national income generated by the increase in timber products output represent the gross secondary benefit to society. However, the output of substitute materials such as structural steel will be lower than it would have been if the program of intensified management had not been undertaken. The reduction in national income due to this decrease must be deducted from the gross benefit.

The analysis shows that savings to consumers will be substantial. For instance it is estimated that.they will amount to 484 million dollars in the year 2000 alone. The net effect on national income due to the increase in wood products output and the consequent decrease in output of industries producing substitute goods is negligible in comparison. For example, the net effect in the year 2000 is estimated to be a decrease in national income of only 12 million dollars. The overall secondary benefits in the year 2000 are therefore estimated to be approximately $472 million. They are estimated to be approximately $163 million and $272 million for 1980 and 1990 respectively.

Discounted benefits

Table 3 shows only secondary benefits in selected years. A fuller analysis requires examination of benefits and costs over all years in the study period. Results of such an analysis are presented in table 4. Overall secondary benefits for the 30-year period are shown to be $6.7 billion before applying discount factors. These benefits amount to $2.8 billion if they are discounted to the present time using a 5-percent discount rate. They amount to $1.3 billion when discounted at 10 percent. The costs of the intensified timber management program were estimated to be $69 million per year. If these are discounted and deducted from the above benefits, net benefits of $1.7 billion and $663 million are obtained with 5-percent and 10-percent discount rates respectively. As illustrated in table 3 substantial net benefits would occur even with higher interest rates.

Other impacts of intensified management program.

The quantitative analysis in this report has been restricted to the impacts of the intensified management program on consumer savings and national income. This program would also have direct and substantial impacts on profits, employment, and payrolls in the timber products industries and those producing substitute products. The analysis suggested, for example, that an intensified program would increase employment and payrolls in the timber industries. Such potential gains could be important in relation to programs to combat poverty both directly and indirectly as a means of stemming the flow of low-income families to densely populated urban areas. In addition, it should be noted that the timber industries provide a wide spectrum of employment opportunities for skilled and unskilled workers.

Intensified management programs may also be important in relation to the national goal of achieving price stability through combating inflationary trends in the economy. Direct price controls can be effective in certain industries manufacturing timber product substitutes such as steel and aluminum. These industries have high concentration ratios and cost-push inflationary characteristics because of their systems of administered prices and powerful labor unions. Recent experience has indicated that direct price controls do not appear to be a practical way of controlling prices in highly competitive industries such as timber processing. A more feasible inflation control measure in these industries is to

Table 4.—Total discounted and undiscounted benefits and costs for period 1970-2000 of intensified timber management[1]

Item	Undis-counted	Discounted at —			
		5%	10%	15%	20%
	Millions of 1970 dollars				
Overall secondary benefits	6,699	2,761	1,313	721	456
Primary costs	2,070	1,061	650	453	344
Net secondary benefits	(2)	1,700	663	268	112

[1] Benefits and costs measured in constant 1970 dollars. Primary benefits such as increased stumpage revenue are not included.
[2] Not applicable.

stimulate increased output. The greatest obstacle to increased output of timber products in the recent past has been inadequate log supply. Intensified timber management is one of the major means by which this obstacle can be overcome in the long run.

Intensified management programs would represent a two-pronged attack on the balance-of-payments problem. They would permit the export of timber products to Japan and other countries; and at the same time they would help stem the rise in timber imports from Canada.

It should be noted that the distribution of economic effects were not investigated. The distribution of effects may be as important as their overall magnitude. A more comprehensive analysis might consider, for example, the impact on income distribution between occupational classes and the effect on regional stability and rates of growth. Such an analysis was not possible under the constraints of the present study but represents a fruitful area for future investigation.

Finally, issues such as aesthetic quality, water and air pollution, rates of use of nonrenewable resources, and optimal rates of growth of the national economy were not considered. These may also be important. Various studies have indicated, for example, that the air, water, and land pollution resulting from the production of materials such as steel, concrete, aluminum, and plastics is of much greater magnitude than for softwood timber products such as lumber and plywood.

METHODOLOGY AND ANALYTICAL ISSUES

The theories and methods of welfare economies are basic to the analysis of changes in economic and social benefits discussed above.

The theory of welfare economics depends on the establishment of a social welfare function for the determination of optimal allocation of commodities and resources. The social welfare function is conceived to be an aggregation of individual utility functions on a value judgment basis. The concept in its purest sense is of little practical value.

The social preference criteria of Kaldor, Hicks, and Scitovsky represent attempts to judge whether a given change in the economy is socially preferable to the existing state (Henderson and Quandt).[2] Kaldor's criterion, for instance, says that state A of society is preferable to B if those who gain from A could compensate the losers and still be better off than they would be if state B prevailed. Such criteria are obviously of limited usefulness in choosing between real-world alternatives. Proxy measures of changes in social net benefit are necessary to assess the desirability of intensified timber management programs.

Two types of measures used here are changes in consumer outlays for timber products and substitute materials and changes in the size of national income.

Changes in national income resulting from a program, such as intensified timber management which shifts supply schedules, must be interpreted with care. A reduction in the price of certain commodities resulting from an increase in supply could conceivably lead to a reduction in gross national product measured in undeflated dollars. A price reduction arising from an increase in supply represents, however, a gain in real income. Consumers can obtain a bundle of goods with the same utility as before for less expenditure; the amount saved may then be used to purchase additional goods and services. An overall reduction in consumer outlays for timber products and substitute materials due to an increase in supply must be regarded as a real gain in social benefit.

Effects on consumer outlays

Types of consumer outlays relevant for this discussion are outlays for timber products such as lumber and plywood, substitute materials, and housing and other end products utilizing wood-based materials. Analysis of the effect of intensified timber management programs is best conducted using the supply-demand framework diagramed in figures 1 and 2.

Figure 1 shows the effect of intensified timber management on timber product markets for a single period. S represents the supply without intensified management; S^1 represents the shifted schedule due to intensified management. Consumer outlays for timber products without intensified management is represented by OCAG; with intensified management they would be OJBH. The net change in consumer outlays for timber products would therefore be (GKBH - JCAK). The magnitude and direction of the change depends largely on the elasticity of demand.

Decreases in timber product prices brought about by intensified management would likely lead to an increase in supply of final products such as housing which utilize wood-based materials. This increase in supply would result in a change in consumer outlays of the same type as depicted by (GKBH - JCAK) in figure 1.

An assessment of the impact of intensified management, of course, should not count both the change in consumer outlays for intermediate products and the change for final products. Recognition should, however, be given to the fact that decreases in consumer outlays for competitive products such as structural steel could occur as represented in figure 2. The decrease in the price of timber products causes demand for the substitute product to decrease from D to D^1. Consumer outlays for the substitute product thus decrease from IMRT to ILNU. The magnitude of the decrease depends on the elasticity of supply for the substitute product as well as on the degree to which the demand shifts.

One method of measuring gains to consumers would be to estimate the reduction in outlays for final products such as housing brought about by programs of intensified timber management. Such an approach is, however, less feasible than es-

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[2] Henderson, James M., and Richard E. Quandt. 1971. Microeconomic theory. Ed. 2, 431 p. McGraw-Hill, New York.

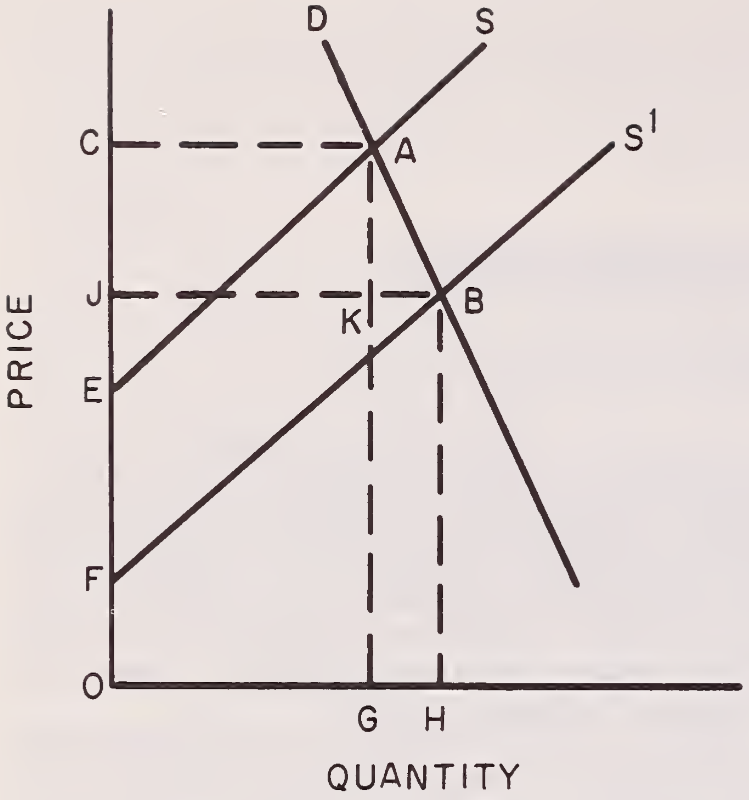

Figure 1.—Supply and demand for wood products under intensified timber management.

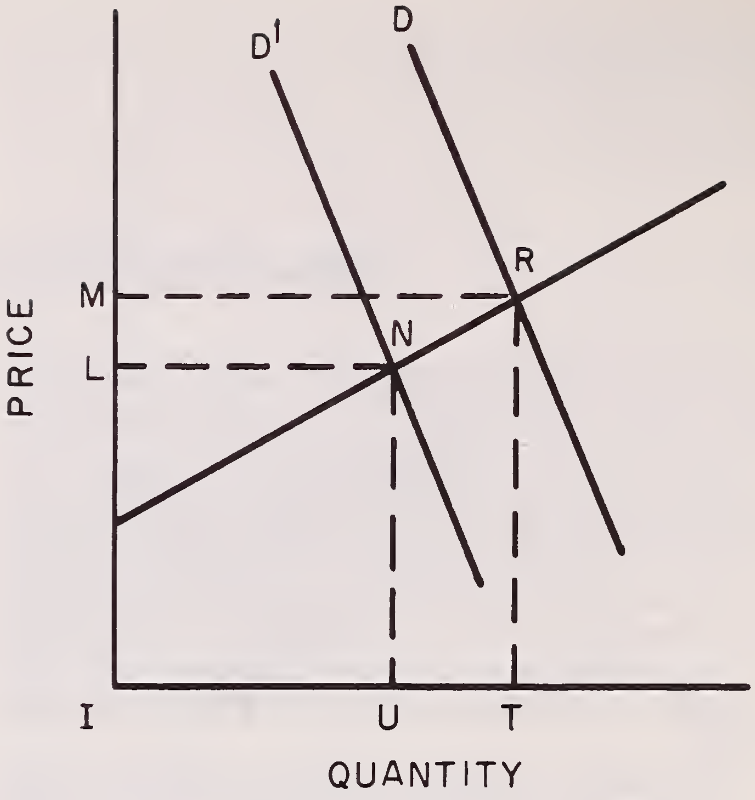

Figure 2.—Supply and demand for substitute product.

timating the overall reduction in consumer outlays in intermediate markets. This involves estimating the net change in outlays for timber products such as lumber and plywood and the reduction in outlays for substitute materials. The overall change may be represented by (GKBH - JCAK) in figure 1 minus (LMRN + UNRT) in figure 2.

Estimation of the potential reduction in outlays for substitute products (LMRN + UNRT) would involve analyses of supply and demand for substitute products. This was not feasible, so proxy measures of this reduction were used. It was reasoned that the increase in output of timber products evaluated at the "new" prices (those that would prevail with intensified management programs) would be an appropriate measure of the reduction in outlays for substitute products. This was considered to be a conservative estimate since it is unlikely that consumers will switch products unless the resulting bill is lower. Thus the area GKBH was taken as a proxy measure for (LMRN + UNRT). The overall reduction in consumer outlays may therefore be estimated by the area JCAK which represents the level of output of timber products without intensified management multiplied by the price reduction brought about by intensified management.

Effects on profits, employment, and payrolls

Change in output and prices in the forest products sector due to intensified timber management programs may have a direct effect on profits, employment, and payrolls in a number of sectors including stumpage sector, logging and timber processing sector, sectors producing substitute materials, and final product sectors using wood materials.

The potential effect on profits may be highlighted by reference to figures 1 and 2. In theory, the area under the supply schedule represents the total cost of production, and as Mishan[3] points out the area between the price line and the supply schedule represents an economic rent, loosely termed "producers' surplus." The "surplus" is synonymous with the aggregate of business profits accruing to individual firms because of variation in long-run cost structures due to such things as differences in management talent and access to scarce factors such as land and capital.

The gain to owners of logging and timber processing enterprises due to intensified management would therefore be represented by an area similar to (FJB - ECA) in figure 1. The gain to firms, such as homebuilders, utilizing wood products in their production processes may be similarly represented. It is of course recognized that profit levels of firms making materials competitive with wood products could be reduced because of intensified timber management. This reduction would be represented by area LMRN in figure 2. Lastly, it is possible that some owners of stumpage will not benefit from intensified management and the demand schedule facing these owners will shift backward. A supply and demand framework similar to the one displayed in figure 2 is applicable. The loss to these stumpage producers would be represented by an area similar to LMRN.

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[3] Mishan, E. J. 1971. Cost-benefit analysis. Praeger. New York.

Hypothetical supply and demand relationships for labor are shown in figures 3 and 4. An increase in the supply of stumpage under intensified timber management will probably lead to an increased demand for inputs by timber processors, and demand for labor will increase from DW to DW[1]. It is hypothesized that supply of labor relationships have a reversed "L" shape—perfectly elastic initially at the going wage (WW) but ultimately becoming inelastic at some maximum level such as ZW. The increase in employment due to intensified management is shown in figure 3 as (YW - XW). With intensified management programs the demand for substitute products would be lower than without intensified management and demand for labor by industries producing substitute products would be DC[1] rather than DC as shown in figure 4. The corresponding reduction in employment would therefore be (YC - XC). Wage rates in substitute products industries may be higher but these industries may have higher capital-output ratios on the average than timber processing. The increase in man-years of employment in timber processing is thus likely to be greater than the decrease in employment in the substitute industries.

The net change in payroll levels will depend on the magnitude of wage differentials in the forest industries vis-à-vis substitute product industries.

Effects on the general economy

Although the most obvious impact of intensified timber management programs is on employment or payrolls in the forestry and timber-processing sectors, or in sectors producing materials that are substitutes for wood products there will be impacts on other sectors of the economy, especially those which supply inputs to the sector under study.

This economic interdependence means that a change in one sector may have a reverberating, "multiplier" effect throughout the whole economy. For example, a one-million-dollar change in the output of the timber-processing sector means an increase in employment in that sector and an increase in the output of sectors supplying inputs to it. This is only the first round effect. Households receiving the extra income spend it and thus stimulate new output. Industries supplying inputs to the timber-processing sector increase their purchases from other sectors which in turn may increase their output, work force, payments to households, and purchases of inputs. This process continues with the effect becoming smaller and smaller in successive rounds. The concept of a multiplier is used to represent the total impact.

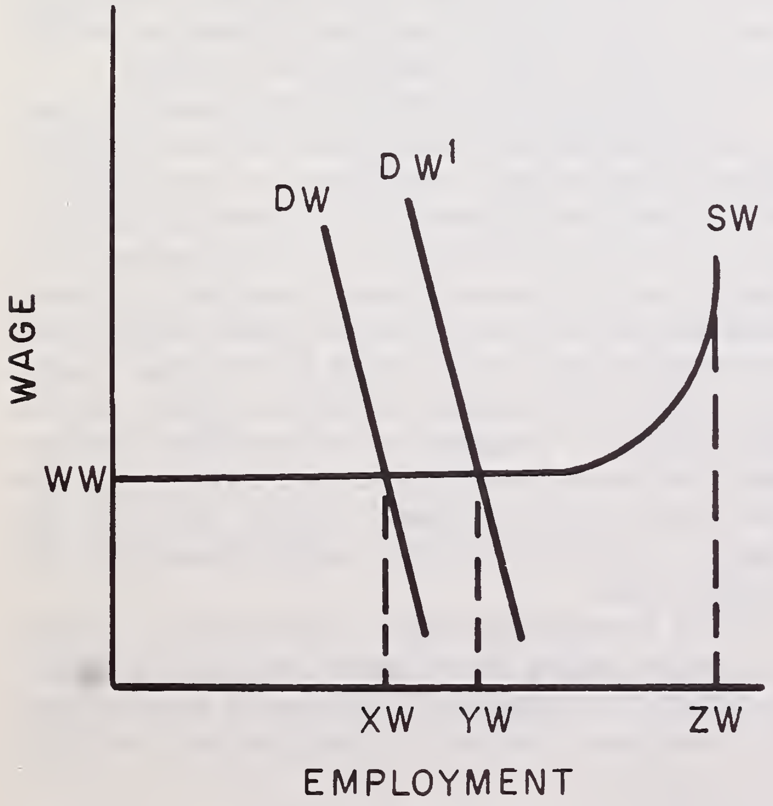

Figure 3.—Demand and supply for labor in forest industries.

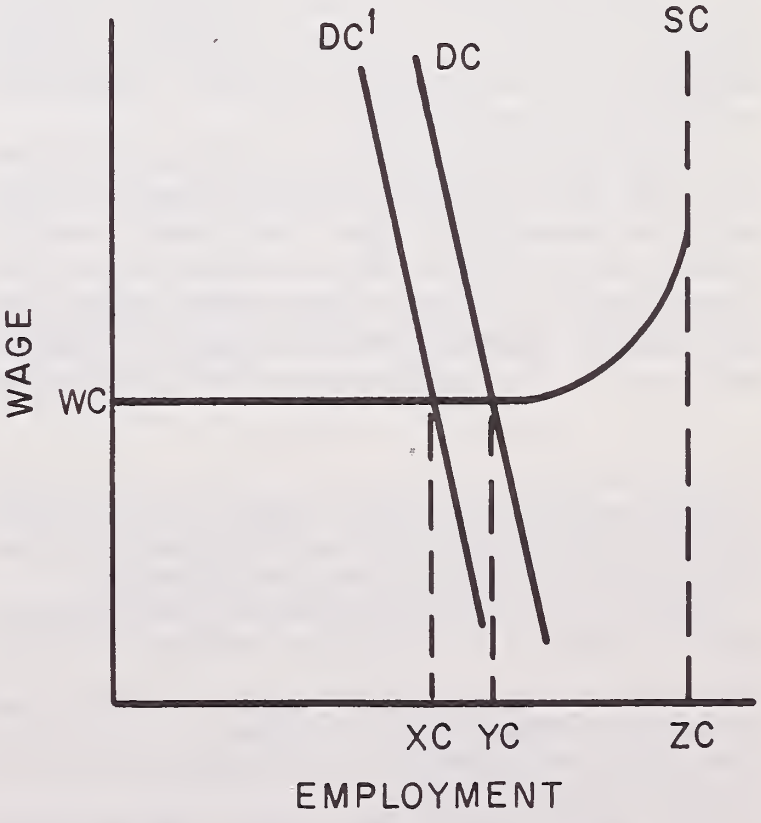

Figure 4.—Demand and supply for labor in substitute product industries.

Multipliers may be output multipliers, income multipliers, or employment multipliers. The output multiplier for a given sector (sometimes referred to as a business income multiplier) is the total increase in output of all sectors combined (in dollar terms) generated by a $1 change in the output of the sector (Little and Doeksen).[4] The income multiplier for a given sector is the total change in income of all households in the economy due to a $1 change in the payments to households by the sector. "Payments to households" cover wages and salaries, business profits, etc. Bradley[5] defines two types of income multiplier. Type I covers only the direct and indirect income effect; type II covers also the "induced" income effect which results from the increase in final demand due to households spending the increase in payments to them. The employment multiplier for a given sector is the change in employment in the whole economy due to a unit change in the labor force in the sector.

Three tools are available for estimating the magnitude of multipliers: (a) export-base (economic base) theory, (b) input-output (interindustry) analysis, and (c) econometric-simulation models.

The input-output approach is covered in a number of well-known texts such as Miernyk[6] and Leontieff[7] and need not be described here. Its advantages as a device for handling complex interindustry relations clearly outweigh its defects such as the assumption of linear production relations. Input-output analysis can be expensive if primary data must be obtained by survey procedures. There are indications, however, that analyses based on secondary data, for example adapting national coefficients to local regions, may give comparable results (Boster and Martin).[8]

The export-base approach is simple and requires much less data. Its major weakness lies in its fundamental assumption that the overall level of employment in a region depends solely on the level of employment in certain basic sectors whose output is largely exported from the region. A related weakness is the arbitrariness with which industries or parts of industries are classed as basic or nonbasic.

The econometric-stimulation approach has received much less use to date than the other two methods and its potential has perhaps not been fully realized. Cross-section or time series data are used to estimate systems of relationships which explain economic phenomena such as the level of regional income and employment in terms of key variables such as output or employment in industries of interest. The impact of varying the level of key variables is then determined by computer simulation. A study by Arthur D. Little, Inc.,[9] is one of the few cases in which this approach has been tried in relation to natural resource development or management.

The input-output approach was judged to be most appropriate for the empirical analysis presented in the next section. The export-base approach was rejected because of its arbitrary nature and because of its doubtful validity in analyzing national effects. The econometric-simulation approach was not considered feasible because of the unavailability of estimated models. Dependence was therefore placed on estimates of income effects and multipliers obtained using the input-output approach.

Several types of effects of an intensified management program have been discussed so far, including effects on consumer expenditures, and direct and indirect effects on income, employment, and output. As mentioned previously, an overall reduction in consumer outlays for timber products and substitute products represents a real gain in national income. Such a reduction must be explicitly accounted for in any analysis. Effects on profits, payrolls, and output must also be covered.

As explained above, input-output analysis may be used to estimate either business income (output) effects using output multipliers, or household income effects using (household) income multipliers. Business income effects may be misleading as indicators of real income gains since they represent the gross value of interindustry sales rather than the value-added concept used in national income accounting. The household income effect on the other hand, is a measure of value-added and correctly portrays the effect on national income. For this reason the household income effect is the measure employed in the empirical analysis discussed below.

Direct income and output effects may be important when gaging the relative impact of a change on different industries or sectors of an economy. This analysis, however, is concerned only with the overall magnitude of effects rather than with their distribution. Furthermore the household income multiplier, as estimated by input-output analysis, takes into account both direct and indirect effects. It represents the effect on profits and payrolls in those sectors directly affected by programs of intensified timber management, and in any other sectors throughout the economy in which changes are induced. Only the household income effect was investigated in the empirical analysis. Direct effects on income and output were not computed. Employment effects were not analyzed either, on the premise that they would be highly correlated with changes in national income.

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[4] Little, Charles H., and Gerald A. Doeksen. 1968. An input-output analysis of Oklahoma's economy. Okla. Agric. Exp. Stn. Tech. Bull. T-124, 31 p. Okla. State Univ., Stillwater.

[5] Bradley, Iver E. 1967. Utah interindustry study: An input-output analysis. Univ. Utah, Utah Econ. and Bus. Rev. 27(7):1-13.

[6] Miernyk, William H. 1965. The elements of input-output analysis. 158 p. Random House, New York.

[7] Leontieff, Wassily. 1966. Input-output economics. 257 p. Oxford Univ. Press, New York.

[8] Boster, Ronald S., and William E. Martin. 1972. The value of primary versus secondary data in interindustry analysis: a study in the economics of the economic models. Ann. Reg. Sci. 6(2):35-44.

[9] Arthur D. Little, Inc. 1966. The impact of the proposed Redwood National Park on the economy of Del Norte County. San Francisco. March.

The above discussion outlines the theory and methodology available for estimating the impact of the intensified timber management program described in the recent Forest Service report on the timber situation.[10] The material in the following section describes the development of quantitive estimates of the impacts on consumer expenditures and national income.

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[10] Op cit. The outlook for timber in the United States.

EMPIRICAL ANALYSIS

The beginning point in the analysis was the Forest Service projections of softwood timber demands and supplies and the assumptions on relative prices (table 1). These data were used to estimate demand and supply relationships by means of both least squares and graphical analysis. The relationships are presented in equation form in table 5. It should be recognized that these estimates are based on a number of assumptions. For example, it does not take into account the fact that supply schedules used are interdependent; i.e., a high harvest level in 1980 will, because of depletion of timber inventory, shift the 2000 supply schedule more than would a low harvest level in 1980. Demand may be similarly affected because of irreversibility of substitution trends; for instance, a high price in 1990 may lead to a greater backward shift in the demand schedule in later years than would a lower price. Nevertheless, the estimated equations must be regarded as "best available" at the present time.

Consumer savings

The most appropriate estimate of savings to consumers, as explained above, is the timber products consumption level that would prevail in the absence of the intensified management program multiplied by the reduction in price brought about by the program. This allows for a reduction in expenditures for substitute products as well as for the increase in expenditures for wood products. These savings are shown in table 3.

National income

The other component to be assessed in estimating overall gains due to intensified management was the net effect on national income of increasing the output of timber products and decreasing the output of substitute products. As a preliminary step, a review was carried out of selected studies dealing with the estimation of multipliers associated with forestry and the forest industries. This review, presented in Appendix A, suggested a number of possible multiplier values depending on the region being studied and the method of analysis.

No single value was judged appropriate for this study in view of the need to cover the national situation and to give comparable treatment to the forest industries and to industries producing substitute products. The 1963 national input-output model of the U.S. Department of Commerce[11] was therefore used to calculate household income multipliers. These multipliers were type I and did not include any possible induced effect due to expan-

Table 5.—Softwood timber demand and supply relationships for years 1980, 1990, and 2000

Item	Year	Equation[1]
Demand	1980	$P = 264.697 - 2.540Q$
	1990	$P = 263.768 - 2.182Q$
	2000	$P = 310.453 - 2.682Q$
Supply without intensified timber management	1980	$P = -277.683 + 8.544Q$
	1990	$P = -591.333 + 15.000Q$
	2000	$P = -587.763 + 15.132Q$
Supply with intensified timber management	1980	$P = -292.706 + 8.544Q$
	1990	$P = -635.500 + 15.000Q$
	2000	$P = -651.514 + 15.132Q$

[1] P = Price per thousand board feet in 1970 dollars.
Q = Output in billion board feet.

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[11] U.S. Department of Commerce. 1969. Input-output structure of the U.S. economy: 1963. US Dep. Commer., Off. Bus. Econ., Surv. Curr. Bus. 49(11):16-47.

sion of final demand resulting from an increase in household spending. Type II multipliers would have allowed for this induced effect, but the substantially greater computational effort was not warranted in view of the fact that expansion in final demand due to increased output of one sector would be offset due to decreased output of the other sector.

Consideration was given to computing weighted average multipliers covering groups of industries. Studies by Koenigshof[12] and others suggest, however, that the most likely type of product substitution deterred by intensified timber management programs would be the replacement of lumber by steel in floor and wall framing. Multipliers and household income effects were therefore, computed only for the lumber and wood-products sector and for primary iron and steel manufacturing. They are as follows:

	Lumber and wood products	*Primary iron and steel*
Income effect	0.89	0.91
Income multiplier	2.45	2.14

The income effect indicates that household income will increase by 89 cents in response to a $1 increase in wood-products output. The income multiplier suggests that income for the Nation will increase by $2.45 if payments to households by the lumber and wood-products sector go up by $1. Multiplying the household income effect by the change in value of output of timber products due to the intensified management program gives an estimate of the total income effect originating in the wood-products sector. A similar estimate can be obtained for the iron and steel sector. The difference between these estimates is thus a measure of the overall income effect.

As discussed above, the increase in expenditures for timber products due to intensified management was taken as a conservative estimate of the decrease in expenditures for substitute products. It was measured by the increase in output multiplied by the price that would prevail if the intensified management program was adopted. Computation of the national income effect is shown in table 6. It should be noted that no attempt was made to project values of income multipliers. Static values obtained from the 1963 input-output model were used for each selected year.

Table 6.—Computation of income effect due to intensified management, 1980, 1990, and 2000

Item	1980	1990	2000
Increase in wood products output due to intensified management . . . . billion board feet	1.4	2.5	3.6
Wood products price per thousand board feet with intensified management . . . . 1970 dollars	137.00	149.60	165.60
Increase in output of wood products due to intensified management . . . . million 1970 dollars	191.8	374.0	596.2
Household income effect per $1 of output for wood products . . . . dollars	0.89	0.89	0.89
National income generated by increase in wood products output . . . . million 1970 dollars	170.7	332.9	530.6
Household income effect per $1 of output for primary iron and steel . . . . dollars	0.91	0.91	0.91
Reduction in national income due to decrease in output of substitute products . . . . million 1970 dollars	174.5	340.3	542.5
Net reduction in income due to intensified management . . . . million 1970 dollars	3.8	7.4	11.9

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[12] Koenigshof, Gerald A. 1974. Comparative in-place cost between wood and steel residential floor and wall framing. USDA Forest Serv. Res. Pap. WO-*22*, 56 p.

APPENDIX A—REVIEW OF SELECTED MULTIPLIER STUDIES[1]

Several analyses of multiplier effects for the forest industries sector have been offshoots of general input-output studies. Bradley (1967) in 1963 conducted an interindustry study for the State of Utah; his lumber and wood-products sector included sawmills, millwork plants, household furniture, and other furniture products. The type II income multiplier for this sector was estimated to be 1.95, implying that for every $1 increase in payrolls in lumber and wood products $1.95 of household income will be generated. This includes the effect due to households respending any income received in the form of wages, profits, etc. Bradley noted that sectors with high direct income payments to households tended to have lower income multipliers.

The lumber and wood-products sector ranked 27th out of 39 sectors in terms of the income multiplier. In terms of direct payments to households it ranked 15th. Approximately 37 cents out of every dollar spent by this sector went to households. Sectors with the highest income multipliers were food retail (4.96), livestock (4.33), and building-general contractors (4.02). Bradley estimated that the income multiplier associated with the "traveler" industry (including tourism) was about 2.40.

The output multiplier for lumber and wood products was 1.32, giving it a rank of 30. In other words a $1 increase in output might be expected to generate a total increase of $1.32 in the output of the processing sectors of the Utah economy (including lumber and wood products). Food retail (2.37), building-general contractor (2.19), and livestock (2.10) were, again, the major sectors in this respect.

Sandoval (1968) utilized the 1960 input-output model of the New Mexico economy in a similar manner. He determined that the type II income multiplier for lumber and wood products was 1.97 (or 2.23 if respending by government as well as by households was allowed for). Lumber and wood products ranked about 10th out of 42 sectors in terms of income multipliers. Approximately 31 cents of every $1 spent by the lumber and wood-products sector went directly to households. Value added by the sector represented about 0.5 percent of the State total.

Rafsnider and Kunin (1971a) developed an input-output model for Idaho for 1967 based on national coefficients. Forestry and forest industry was covered by the following 10 sectors:

- Forest, Greenhouse and Nursery Products (FGNP)
- Forest and Fishery Products (FFP)
- Agricultural, Forestry and Fishery Service (AFFS)
- Logging Camps and Logging Contractors (LCLC)
- Sawmills and Planing Mills (SPM)
- Millwork (M)
- Veneer and Plywood (VP)
- Other Wood Products (OWP)
- Pulp Mills (PM)
- Paperboard Mills (PB)

In 1971, as a follow-up to this study they examined the effect of varying Forest Service harvest levels in the State (Rafsnider and Kunin, 1971b). Variations considered were a 25-percent decrease and 100, 200, and 300 percent increases in cut. Changing the level of timber harvest was represented by changing the level of output of the Forest and Fishery Products Sector. These changes influenced deliveries to final demand in the following sectors: Forest and Fishery Products; Agricultural, Forestry and Fishery Services; Forest, Greenhouse and Nursery Products; and Meat, Animals and Miscellaneous Livestock Products (MALP). A patently inappropriate assumption of the analytical procedure was that total gross output would change for only the Forestry and Fishery Products sector. This meant that exports of saw logs would be necessary with increases in timber harvest, and importation of saw logs would take place if the timber harvest was decreased. Because of this assumption the results of their study must be viewed with caution. A major conclusion of the study was that a 25-percent decrease in Forest Service harvest levels would lead to a decrease in total income in Idaho of 1.6 million dollars and that a 100-percent increase would lead to an income increase of 6.6 million dollars. Their estimates of multipliers for the Forest and Fishery Products sector were: output multiplier (1.32); income multiplier (1.38); employment multiplier (1.21). The income multiplier appears to be type I and thus would not include the effect of respending by households.

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[1] Thanks are due to H. F. Kaiser for providing many of the references.

The study by Herbst (1972) was an application of the Rafsnider-Kunin input-output model to a two-county (Valley-Adams) area. The effect of changing the allowable cut on Forest Service lands was assessed by allowing variation in total final demand for the output of (a) logging camps and contractors and (b) sawmills and planing mills. Exports were the only component of final demand allowed to vary. Harvest levels investigated were 100-, 50, and 25-percent increases, and decreases of similar magnitude. Allowance was made for the fact that the Forest Service supplies only 60 percent of the logs used in the Valley-Adams area. A reasonable assumption was made that local forest industry had capacity available to log and process any increase in cut and that any additional requirements for labor could be obtained locally. Herbst computed changes in total gross output, payrolls, and value added, and estimated, for example, that a 100-percent decrease in the level of Forest Service cut would lead to a decrease in total gross output of approximately $15 million.

A recent study (FORMA) by Drake, Randall, and Skinner (1973) demonstrates the versatility of the input-output approach in analyzing the impact of a variety of Forest Service actions. The 1960 New Mexico model described by Sandoval (1968) was adapted to a seven-county area in northern New Mexico after updating to 1968. This northern New Mexico model had 29 sectors, including sectors for (a) logging contractors, (b) sawmills and planing mills, (c) other wood-processing and furniture. In addition, households and four Forest Service activities (range, timber, recreation, and "other") were treated as individual, endogenous sectors. An interesting adjunct to the input-output model was a matrix of occupational labor coefficients (OLC) covering 21 occupational groups. The objective of this development was to allow the study team to investigate the differential impact of programs on individual occupational groups. The use of the OLC matrix in this connection is discussed in Drake (1973).

Some of the case studies considered in the FORMA investigation were new programs for road construction or maintenance; change in grazing fees or grazing allotments; reduction in mining activity; and establishment of a handcrafted furniture enterprise. The case study of primary interest here was, however, an assessment of the impact of shifting $1 million from the Forest Service timber management budget into the budget for recreation. This change resulted in a $9 million decrease in the gross output of the region including a $1.4-million loss in household income. It appeared that distinct changes would occur in the level of employment and its distribution between occupational groups. For instance, it was estimated that modest gains would accrue in the office worker and lower skilled worker classes and that substantial reductions in employment would take place in the craftsmen and operatives class. It was estimated that there would be an overall reduction in regional employment of 103 man-years.

The study by Kaiser and Dutrow (1971) encompassed three subregions in the South: South Atlantic, East South Central, and West South Central States. They presented output, income, and employment multipliers for the South as a whole for a variety of sectors in the forest economy. For example, they report output multipliers for logging contractors (1.65), pulpwood producers (1.34), sawmills and planing mills (1.87), veneer and plywood mills (2.13), and pulpmills (2.02). Income multipliers were presented in terms of changes per $1 change in final demand for the sector. This information may be used to compute type I income multipliers for various sectors such as logging contractors (1.14); sawmills and planing mills (1.72); veneer and plywood plants (1.86); and pulpmills (3.60). Information on employment effects may be similarly used to compute employment multipliers representing the change in regional employment generated by a one-man-year increase in employment in a given sector. These multipliers were 1.16 for logging contractors; 1.62 for sawmills and planing mills; 2.11 for veneer and plywood plants; and 3.71 for pulpmills.

Analysis of forest resource issues in the above mentioned studies was conducted by adapting information from more general input-output models. Bromley, Blanch, and Stoevener (1968), Reimer (1970), and Hughes (1970a), on the other hand, developed input-output models from primary data with the specific purpose of analyzing such issues.

Reimer studied the impact of establishing new forest industries in four counties in southern Indiana. He reported a total output multiplier for the forestry and wood-using sectors of 3.14. Hughes conducted a comprehensive study of the role of forestry in the economy of Itasca County, Minnesota. He reported that direct payments to households represented 63 percent of every dollar of sales (mainly stumpage) by the timber production sector. For timber operators and sawmills the percentages were 39 and 29 respectively. He obtained output multiplier estimates of 3.45, 3.00, and 3.11 for timber production, timber operators, and sawmills respectively. Having obtained such multipliers, he proceeded to consider the impact of various changes in the county's economy. Of particular interest was his estimate of the impact of making available an additional 50,000 cords of pulpwood stumpage with a total value of $75,500.

He estimated that an additional $185,000 of sales by other sectors (including households) would be generated if such a volume were sold.

Bromley, Blanch, and Stoevener in their study of Grant County, Oregon, developed a model with 14 processing sectors including a lumber sector which represented all wood processing in the county. The output multiplier for the lumber sector was 1.28, giving it a rank of 6th out of 14. In terms of impact on household income the lumber sector ranked 7th with a multiplier of 1.17. It should be noted, however, that this was a type I estimate which did not include the effect of respending by households. The multiplier would have been larger if households had been treated as an endogenous sector.

The studies referred to above are all based on input-output analyses. Several studies using the export-base approach are of interest. Johnson (1972) estimated that 43 percent of total employment and 51 percent of total personal income in western Montana came either directly or indirectly from the wood products industry. Multiplier estimates were derived by dividing total employment or earnings by the level of basic employment or earnings. She defined manufacturing, Federal Government, agriculture, mining, and railroads as basic (primary) industries. Her employment multiplier estimates were 3.07 for the State and 2.73 for western Montana. Estimates of income multipliers were 3.09 and 3.29 respectively.

As a supplementary part of the study Johnson examined the potential impact of a reduction in timber harvest levels. She estimated that a 20-percent reduction (150 million board feet per year) would lead to a loss to the wood products industry of 750 jobs and $7 million in wages, salaries, and proprietors' income. The Statewide impact was assessed at 2,370 jobs and $22 million in income (approximately 1 percent of Montana's total employment and income in 1969). Local impacts were estimated to be much greater; for instance, it was speculated that employment in western Montana might decline by 3 percent and income by 5 percent. It was also estimated that a 30- to 35-percent reduction in timber harvest (approximately 250 million board feet) might lead to a 1.4-percent decline in employment and a 1.7-percent decline in personal income for the State as a whole. For western Montana, these figures were 5.1 percent and 7.8 percent respectively. It is interesting to note that the 30- to 35-percent reduction in cut was thought to be the effect that an immediate ban on clearcutting would have.

Convery (1973) in a small-area study in Tennessee designated basic sectors on a judgment basis in a manner similar to that of Johnson. Basic sectors were agriculture, forestry and fisheries, mining, and basic manufacturing. He estimated that each basic job in 1970 generated 0.91 other jobs; that is, his employment multiplier estimate was 1.91. He also made estimates of the timber volume "required" per employee in saw-log harvesting (261 M board feet), pulpwood harvesting (471 M board feet), sawmilling (74 M board feet); and pulp and paper manufacturing (164 M board feet).

Maki in his Pacific Coast studies (Maki, 1967 and 1968; Maki, Schallau, and Beuter, 1968) used the excess-employment techniques to estimate the portion of the employment in each area which was engaged in economic base activities. This technique accepts the national distribution of employment among industries as a norm. Any industry in a local area or region with employment in excess of this norm was considered to be producing for export markets. This allowed him to construct "timber-dependency indicators" for various areas, defined as the percentage of excess employment in the area which was in timber-dependent manufacturing and forestry activities. He used an export-producing employment multiplier which is estimated by either the ratio of total employment in an area to the level of (1) commodity-producing employment, or (2) excess employment. His multiplier estimates for the Douglas-fir region are 2.6 using commodity-producing employment and 6.0 using excess employment. The commodity-producing estimates for individual areas within the region were consistently lower than the estimates based on excess employment. This disparity is not unexpected since commodity-producing employment will always be greater than excess-employment because of production for local markets.

In concluding, mention should be made of the study by Hair (1963). He estimated value added attributable to timber by apportioning value added in an industry using wood or wood products in proportion to the cost of various materials consumed. He estimated that about 6 percent of gross national product originated in timber-based activities and that about $25 of value added was associated with every $1 of timber harvested.

APPENDIX B—LITERATURE ON MULTIPLIER ANALYSIS

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McKillop, William.
1974. Economic impacts of an intensified timber management program. USDA Forest Service, Division of Forest Economics and Marketing Research, Washington, D.C. Research Paper WO–23, 16 p.

This analysis shows that substantial benefits would accrue from an intensified softwood sawtimber management program described in the recent Forest Service study, “The Outlook for Timber in the United States.” It was estimated that in the year 2000 output of softwood timber products would be 7 percent higher and prices 5 percent lower with this program than they would be if the program was not undertaken. Savings to consumers, which would result from program-induced changes, were estimated to be $484 million in year 2000; net secondary benefits were estimated to be $472 million after allowing for the reduction in output of substitute materials. Substantial secondary benefits were estimated for other years in the study period.

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